University of Michigan Lecture Archiving and related activities of the U-M ATLAS Collaboratory Project

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• Goal: to study and advance the technologies and practices required for the organization and execution of modern, large-scale collaborative research experiments
• specifically: using videoconferencing and web archiving to help the ATLAS experiment
• Activities since 1999
  – archiving of ATLAS meetings and software tutorials
  – development of automated lecture archiving systems
  – development and promotion of Lecture Object
  – QoS bandwidth reservation testing
  – design and implementation of group-to-group video conferencing facilities at CERN and Michigan
Some current ATLAS Collaboratory Project activities

- Shaping Collaboration 2006 conference
- Collaborative Tools Research Experience for Undergraduates (planned for summer 2008)
  - let bright CS undergrads work on our HEP collaborative tools problems
- Fall 2007: pilot project to test remote teaching facility
  - this allows faculty to teach their classes remotely while visiting CERN during the semester
People

- Homer A. Neal – PI, Director
- Steven Goldfarb – Research Scientist
- Shawn McKee – Advisor, Research Scientist
- Jeremy Herr – Project Manager
- Tushar Bhatnagar – Engineering Student (IR tracking)
- Robert Vogt – Electrical Engineer (ultrasound tracking)
- Mitch McLachlan – Media Specialist (recording processes)
- Curtis Hiller – Web development, programmer intern
- Alumni
  - Jim Irrer - engineer
  - Cang Ye - engineer
  - Giosue Vitaglione – software developer
  - Eric Myers – software developer
  - Kyle Wilamowski – media specialist
Timeline: Lecture Archiving

• 1997: initial development of web lecture recording/viewing software
• 1999 – Present: Web Lecture Archive Project funded by ATLAS and U-M to record events:
  – Software Tutorials
  – Physics Workshops
  – Large group meetings
• 2003: $250,000 grant from NSF (partnering with APS) to develop more automated recording, archiving and tracking system
• 2005: Patent filed for infrared tracking camera system
• 2006–07: MScribe Pilot Project
  – recorded 8 entire U-M courses using automated carts
• 1999 – Present: ongoing development:
  – Lecture Object specification
  – Web Lecture viewer software
  – media formatting and processing software
• 2007: Our archive now has 1600+ lectures
What is a Web Lecture?

• Low-bandwidth media-rich presentation viewable with:
  – any web browser
  – RealPlayer plug-in

• Media streams:
  – lecturer’s audio
  – lecturer’s video
  – high-res slide images
  – high-res chalkboard images

• Features
  – slide index
  – ability to “jump around”
  – platform independence
  – low bandwidth
  – ability to evaluate usage
What is a Lecture Object?

- Originally proposed by our team in 2000 at an international conference
- A standardized data object containing metadata, timing, high-res media
- Designed for
  - Longevity
  - Sharing among multiple institutions
  - Flexibility in viewing formats

Transformations

Lecture Object

Dublin Core, IEEE LOM meta data

mpeg-4

jpeg

XML Description

Description

Dublin Core, IEEE LOM meta data
Recent Recordings

- some recent recordings
  - ATLAS Week, February 2007
  - Trigger Aware Analysis Tutorial, 23 March 2007
  - ROOT Workshop, 26 March 2007
  - Physics Analysis Tools Workshop, Norway, 26 April 2007
  - CTEQ Workshop, Michigan, 14 May 2007
  - ATLAS Week, Glasgow, July 2007
  - First ATLAS Physics Workshop of the Americas, SLAC, 20 August 2007

![Graph showing growth of UM-WLAP Lecture Archive 2003-2006](image)
Contents of Lecture Archive

- The ATLAS experiment
  - software tutorials
  - physics workshops
  - large meetings
- Special CERN events and workshops
- Special University of Michigan events
- U-M Saturday Morning Physics (since 2001)
- American Physical Society (APS) meetings
- Int’l Conference on Systems Biology 2005 at Harvard
- MScribe classroom recordings (2006-07)
  - American Culture, History of Art, Physics, Statistics, Psychology, Bioinformatics, School of Information
• MScribe is the next step toward large-scale automation of web lecture recording
• Its new developments and technology are being used simultaneously to benefit ATLAS
• Goals of MScribe Pilot Project (2006-07):
  – Completely automate the recording of classroom lectures
  – Develop a robust tracking system to eliminate human camera operator
  – Study how students use recordings and the ramifications of the technology
MScribe – Technical Achievements

- 4 automated, self-contained, portable carts built. They record:
  - audio
  - video
  - slides, laptop screen, annotations
  - chalkboard writing
- 8 courses, 200 hours of video recorded
- recordings accomplished by unskilled student helpers (press START and STOP)
- RealPlayer Web Lectures and video iPod lectures were provided for students online
- venues ranged from small classrooms to large auditoria
- chalkboard writing and tablet PC annotations were captured
- automatic processing software developed and improved
not sure if i’ll use these pics yet...
MScribe – Pedagogical Studies

• Questionnaire results:
  – 58% of all students used MScribe
  – class attendance was not noticeably affected
  – students spent more time in class taking notes
  – students spent more time reviewing lecture content / notes
  – students spent more time studying for exams

• Focus group findings:
  – MScribe technology allows students to pay closer attention to the ideas in a lecture.
  – Some use the live lecture to outline important points and to “absorb” the information, and detail the notes by listening again later.
  – Student use patterns differ.

• Server log analysis:
  – students fast forwarded through web lectures, but did not jump around much
  – students made heavy use of web lectures right before exams
MScribe benefit to ATLAS

- MScribe recording system now installed on a laptop
  - Drastically more portable than cart, laptop can be taken all over the world (auto-tracking not yet included)
  - Allows us to post ATLAS talks faster
- Laptop system used to record 5 ATLAS events (120 talks):
  - Physics Analysis Tools Workshop (April 2007, Norway)
  - CTEQ Workshop (May 2007, Gull Lake, Michigan)
  - ATLAS Week (July 2007, Glasgow)
  - UM-CERN REU Student Talks (August 2007, CERN)
  - First ATLAS Physics Workshop of the Americas (August 2007, SLAC)
- New archiving/processing software also used for these talks
- We hope to use tracking system for ATLAS talks soon
## Survey of Tracking Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Description</th>
<th>Price/Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human camera operator</td>
<td>Intelligent tracking that generates pleasing video</td>
<td>Very expensive, gets tired after several hours</td>
</tr>
<tr>
<td>Ultrasonic</td>
<td>Probably accurate enough for tracking a lecturer</td>
<td>Requires extensive permanent installation</td>
</tr>
<tr>
<td>Radio Frequency (RF)</td>
<td>Almost reasonably priced (6,000 USD)</td>
<td>Slow and insufficient accuracy, especially indoors</td>
</tr>
<tr>
<td>Radio Frequency (RF) BlueSoft</td>
<td>Almost reasonably priced (10,000 USD), more accurate than RF</td>
<td>Requires extensive set-up and calibration</td>
</tr>
<tr>
<td>Position Sensitive Detectors (PSD)</td>
<td>Extremely accurate</td>
<td>Not sensitive enough at long range</td>
</tr>
<tr>
<td>IR quad detector</td>
<td>Inexpensive, accurate</td>
<td>Will always require a pan-tilt platform</td>
</tr>
<tr>
<td>“passive” IR Used in Boeing factories</td>
<td>Inexpensive (4000 USD), simple and very accurate</td>
<td>Very easily distracted by any reflective objects in the room</td>
</tr>
<tr>
<td>“active” IR Using IR LED necklace</td>
<td>Inexpensive (4000 USD), simple and very accurate</td>
<td>Confused by incandescent lights and bright sunlight</td>
</tr>
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Active IR tracking system used for MScribe 2006-2007

- “Active” Infrared used 2006-07
  - necklace chain of bright IR LED’s
  - CCD camera follows it
  - PTZ commands sent to video camera

- This system satisfies our criteria
  - Portable: sits on a cart
  - Robust: simple design makes it very robust
  - Affordable: currently under 4 000 USD
  - No expert intervention: start it and it works
  - Little setup: almost no calibration required
  - Accurate to within centimeters

- Weakness of this system
  - confounded by incandescents, sunlight
  - can only be used in certain rooms
Active IR Tracking System – Recent Improvements

• Made improvements to IR tracking system
  – optimized filter arrangement
  – found extremely bright wide-angle IR LEDs
  – fully exploited camera settings
  – can now be used in all rooms on campus

new necklace with super-bright IR LEDs
Tracking Camera Current Research

- **Necklace Design**
  - testing fiber-optic options
  - parallel chain of wide-angle IR LEDs (120°, 8mW/sr)
  - super-bright wide-angle Malaysian LEDs (120°, 45mW/sr) with special high-current circuitry to drive them from battery pack

- **Flashing LED necklace under development**
  - will further improve signal-to-noise ratio

- **Testing Tracking Algorithms**
  - Modularizing current code
  - Generating database of position data
  - Trying to mimic human camera operator

- **Ultrasonic Phase-Difference array**
  - currently developing this completely different tracking technology in parallel with improvements to IR system
  - see next page...
Ultrasound Tracking System

- Necklace and receiver system, using ultrasound instead of IR:
  - necklace sends 40 kHz pulses instead of always-on LEDs
  - an array of 4 ultrasonic receivers on a 10cm² circuit board receive pulse at slightly different times. The phase difference is used to calculate angle

- Expected advantages
  - no competing noise in this medium
  - lower power consumption, longer battery life
  - can send synchronized RF pulse from necklace to calculate distance (3D position will enable better tracking/zooming)
  - can hopefully eliminate need for pan-tilt platform
U-M Campus-Wide Recording Service

- Already developed expertise and hardware/software tools over 8 years
- Have trained staff in place
- Requesting start-up funds from University to start a campus-wide recording service
- Because everything is digital and mostly automated, costs/pricing are low
- could become a model for CERN lecture recording service
Lecture Object Development

• MScribe technical advisory committee is working on refining the standard

• We are collaborating with CERN in this development. Gregory Favre (CERN IT) is working to make SMAC support it.

• Next versions of the Lecture Object will:
  – support arbitrary numbers of streams
  – support access control, authorization, copyright
  – remain simple, minimal and easy to use
  – be targeted to lectures, not generalized “learning objects”
Users of Lecture Object

• Using a simple, open, well-defined global archival standard will:
  – preserve important material far into the future
  – encourage multiple institutions to share their archives
  – enable shoe-string operations as well as well-funded groups to easily produce compatible content

• Archives using UM-WLAP technology and Lecture Object maintained by:
  – University of Michigan
  – CERN
  – American Physical Society (APS)
  – Fermilab
Advanced Indexing and Search using BlueStream

• BlueStream is an online environment at the University of Michigan with powerful tools for working with digital video, audio, images, and documents.

• The ATLAS Collaboratory Project, through WLAP and MScribe, has made hundreds of hours of video available online.

• Clearly, powerful search and indexing is needed.

• BlueStream has tools that ingest video, images and metadata and:
  – transcode it to multiple formats
  – convert speech to text to index the video stream
  – perform OCR on the slide images
  – provide search functions that take the user directly to a point in the video

• We have begun working with this tool to provide advanced search capability for some classroom lectures
The Future

- Totally automated room installations
  - record lectures at times specified in online agenda
- ultra-portable recording carts
  - entire system including tracking can be checked on airplane
- desktop recording software
- make many display formats available (esp Flash)
- multiple-person (and audience) tracking
- integration with other lecture recording systems:
  - SMAC
  - Apple’s new lecture recording system (name?)
  - EVO
Links

• To view ATLAS talks:

  www.wlap.org/atlas

• Web Lecture portal:
  – http://www.wlap.org

• ATLAS Collaboratory Project
  – http://vesuvio.physics.lsa.umich.edu/acp